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Measurement of severity of sports injuries: an epidemiological study

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Objective: To evaluate the severity of sports injuries in relation to the severity of injuries due to other causes and in relation to type of sport, using generally applied measures of injury severity.

Subjects: A total of 12 403 patients, 4-50 years old, who were treated in the trauma department of the Groningen University Hospital for a sports injury, from January 1990 until January 1997.

Method: All patients treated because of an injury entered the study. A distinction was made between injuries caused by playing sports, home and leisure accidents, traffic accidents and violence. The severity of the injuries was assessed by using the criteria of rate of admission, Injury Severity Scale (ISS). Finally the sports injuries were analysed with regard to type of sport.

Results: In total, 57 760 injuries were registered. After injuries due to home and leisure accidents (44%; 25 228) sports injuries (21%; 12 403) were the most frequent cause of injury. Of the patients with a sports injury, 7.9% (980) were admitted, which is more than with home and leisure accidents (6.7%; 1690) but less than with traffic accidents (21.5%; 2202) and violence (9.3%; 364). In a majority of cases, admission was related to a limited number of types of sport. The mean ISS of sports injuries was low, as with injuries following home and leisure accidents and violence. The percentage of sports injuries with an ISS higher than or equal to 16 and the percentage mortality were both low in comparison to injuries due to violence or traffic accidents.

Conclusions: Sports injuries rank second highest in terms of cause of injury, after home and leisure accidents; and rank third in terms of severity, after traffic accidents and violence. Even though the ISS is low, sports injuries may have serious consequences.

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Introduction

In the Netherlands playing sports is a popular way to spend spare time; 30–40% of the population practise some form of sports.^{1,2} In spite of the (obvious) benefits, such as increase of physical fitness, playing sports can also have disadvantages, such as the occurrence of injuries. The need for medical health care in combination with absenteeism from work resulting from sports injuries³ incur high expenses; these are often considered to be unacceptably high.⁴ To weigh the importance of sports injuries in terms of costs, need for medical health care and absenteeism from work or school in relation to other causes of injuries, it is important to get some insight into the severity of these injuries.^{5,6} Until now, relevant information has been limited and not suitable for comparison.^{1,5,7}

Estimates of the total number of injuries in the Netherlands, irrespective of their origin, vary from 5.9⁵ to 10 million⁸ annually, in a population of 16 million inhabitants. Playing sports accounts for approximately 2.9 million injuries⁵ and 1.1 million (38%) sports injuries are medically treated, of which 209 000 (19%) are treated in a hospital.⁵

The objective of this study is to analyse the severity of sports injuries in relation to injuries due to other causes. Furthermore, severe sports injuries are studied in relation to type of sports performed.

Methods

The University Hospital Groningen (UHG) is a 1056-bed hospital. In the city of Groningen and the surrounding region the hospital plays a major role as emergency care centre for trauma victims. Also hospitals from the north of the Netherlands refer patients when special trauma care is needed.

All patients treated in the trauma department between January 1990 and January 1997 were included in this retrospective study. Registration was carried out by patient identification, trauma diagnoses (ICD codes), treatment strategy and cause of injury.⁹ Four causes of injury were distinguished: (1) accidents caused by playing

sports, (2) home and leisure accidents (accidents arising in and around home, in places of public resort, not concerning sports injuries), (3) traffic accidents, and (4) violence.

As this study investigates the severity of sports injuries the following severity criteria were used^{5,10–16}: rate of admission, death risk (Injury Severity Scale, ISS) and mortality.

The rate of admission (number of admissions / the number of injured patients) was assessed per cause of injury. The death risk was assessed by using the Injury Severity Scale (ISS). The ISS is an overall index of injury based on the Abbreviated Injury Score (AIS). The AIS scores the severity of anatomical injury in six separate body areas, on a 1–5 scale.^{15,16} The ISS is calculated by summing the squares of the three most severely injured body areas. It extends from 0, no injury, to a maximum of 75 (a nearly 100% chance of death). An ISS higher than or equal to 16 indicates a major trauma.^{11,12} Per cause of injury the mean ISS, standard deviation, median, range and number of patients with a major trauma were computed.

Mortality is defined as dying in the hospital following an injury and expressed per cause of injury.

Finally, severe sports injuries were analysed with regard to type of sport, age and sex. Per type of sport a relatively high number of admissions may well reflect a relatively high number of injuries treated. In order to rule out this confounder per type of sport the rate of admission was computed (the Sport Severity Index).

Statistical analyses were performed by applying the *Z*-test for the equality between two proportions (binominal proportion) and Student's *t*-test for independent values.

Results

Number of injuries, cause of injury, age and sex

In the period January 1990 and January 1997, 57 760 injuries were registered. About half (44%: 25 228) were the result of home and leisure accidents. Injuries caused by sports number 12 403 (21.5%). Of all sports-related injuries 97% of the patients were older than 4 and younger than 50 years; therefore this cohort was used in our study.

In Table 1 the age distribution of the patients is given per cause of injury. Thirty-two per cent (18 483) of the injuries occurred in women.

Injury severity (Table 2)

Rate of admission

The overall admission rate was 10%. The percentage of inpatients was significantly smaller in sports-related injuries (7.9%) ($p < 0.001$) than in injuries due to violence (9.3%) and traffic accidents (21.5%) ($p < 0.001$), but significantly higher than in injuries due to home and leisure accidents (6.7%) ($p < 0.001$).

ISS

The mean ISS for all injuries was 2.5 (SD 3.4). Injuries related to playing sports, home and leisure accidents and violence had a low mean ISS, respectively 2.2, 2.2 and 2.7, whereas traffic

accidents score 4.1 ($p < 0.001$). The percentage of severe sports injuries (ISS ≥ 16) related to the total number of sports injuries (33/12 403 = 0.3%) did not differ from home and leisure accidents (75/25 228 = 0.3%), but was smaller than with violence (47/3918 = 1.2%) and traffic accidents (460/10 240 = 4.5%) ($p < 0.001$). The higher the ISS, the higher the probability of admission ($p < 0.001$).

Mortality

One hundred and forty-four patients died in hospital because of an injury (0.25%). Traffic accidents were the main cause: 94 deaths (68%). Four patients (3%) died as a result of a sports injury.

Severe sports injuries per type of sport (Table 3)

When hospital admission is used as severity cri-

Table 1 Age distribution per cause of injury

Age	Home/leisure	Sports	Traffic	Violence	Rest	Total
5–9	2 215 (8.8%)	471 (3.8%)	635 (6.2%)	43 (1.1%)	42 (0.7%)	3 406 (5.9%)
10–14	2 290 (9.1%)	1 625 (13.1%)	860 (8.4%)	129 (3.3%)	72 (1.2%)	4 976 (8.6%)
15–19	3 101 (12.3%)	2 208 (17.8%)	1 853 (18.1%)	492 (12.6%)	602 (10.0%)	8 255 (14.3%)
20–24	5 874 (23.3%)	3 287 (26.5%)	2 263 (22.1%)	1 160 (29.6%)	1 451 (24.3%)	14 035 (24.3%)
25–29	3 481 (13.8%)	2 126 (17.1%)	1 475 (14.4%)	752 (19.2%)	1 227 (20.5%)	9 061 (15.7%)
30–34	2 594 (10.3%)	1 153 (9.3%)	983 (9.6%)	580 (14.8%)	926 (15.5%)	6 228 (10.8%)
35–39	2 091 (8.3%)	732 (5.9%)	850 (8.3%)	333 (8.5%)	669 (11.2%)	4 675 (8.1%)
40–44	1 892 (7.5%)	496 (4.0%)	727 (7.1%)	253 (6.5%)	543 (9.1%)	3 911 (6.8%)
45–49	1 690 (6.7%)	305 (2.5%)	594 (5.8%)	176 (4.5%)	448 (7.5%)	3 213 (5.6%)
Total (%)	25 228 (100%)	12 403 (100%)	10 240 (100%)	3 918 (100%)	5 971 (100%)	57 760 (100%)
%	44%	21.5%	17.7%	6.9%	9.9%	100%

Table 2 Injury severity outcome measures

Measure	Home/leisure	Sports	Traffic	Violence	Rest	Total
Admission	1 690	980	2 202	364	734	5 885
(%)	(6.7%)	(7.9%)	(21.5%)	(9.3%)	(12.2%)	(10.2%)
ISS mean (SD)	2.2 (2.2)	2.2 (2.2)	4.1 (5.5)	2.7 (3.5)	2.4 (3.7)	2.5 (3.4)
ISS median	1	1	2	1	1	1
ISS range	1–75	1–75	1–75	1–75	1–45	1–75
ISS ≥ 16 (%) ^a	0.3	0.3	4.5	1.2	1.8	1.3
Mortality ^b	11	4	98	10	21	144
Mortality % ^c	0.04	0.03	0.96	0.26	0.35	0.25
Number of injuries	25 228	12 403	10 240	3 918	5 971	57 760

^aNumber of severe injuries (ISS ≥ 16) related to the total number of injuries (percentage).

^bNumber of deaths per cause of injury.

^cNumber of deaths per total number of injuries, as a percentage.

terion, 7.9% (980) of sports injuries can be classified as severe. Sports injuries with an ISS ≥ 16 ($n = 33$) were the consequence of horse riding (47%), soccer (29%), speed skating (15%), swimming (6%) and motor sports (3%). The results of the SSI are reported in Table 3.

Discussion

Next to injuries caused by home and leisure accidents (44%) sports injuries are the most frequent reason (21%) for treatment in a trauma department. Some studies^{5,17-24} confirm these results, whereas other studies report a lower percentage of sports injuries (4–17%).^{10,18-22,24-29} Comparison is difficult, however, because of differences in the structures of health services.

Injury severity

In this study, 7.9% of the patients with a sports injury were admitted. Flood and Mina¹⁰ (Ireland; 7.6%), Lang-Jensen²¹ (Denmark; 8%) and Sandelin *et al.*²² (Finland; 6%) found comparable rates of admission. The chance of being admitted

for a sports injury is higher than with home and leisure accidents, but lower than with traffic accidents and violence, which is verified by other studies.^{1,5} This phenomenon is also observed, as reported by Yamamoto *et al.*,⁷ by using the ISS as a measure for injury severity. This is not surprising because in general the percentage of high energy accidents is much higher with traffic accidents than with other causes of injuries. Not sur-

Clinical messages

- Injuries due to sports participation rank second highest in terms of cause of injury, after home and leisure accidents.
- Regarding the severity of injuries, sports injuries are graded third, after injuries following traffic accidents and violence.
- Although with sports injuries the ISS and mortality is low, this does not rule out the possibility of serious consequences, such as a high admission rate, disabilities and handicaps or high costs.

Table 3 Injury measures per type of sport

Type of sport	Cases ^a	Admission	SSI ^b (%)	ISS $\geq 16^c$	Mortality
Soccer	4341 (35%)	332 (34%)	8	10 (29%)	–
Horse riding	507 (4%)	108 (11%)	21	15 (47%)	1 (25%)
Speed skating	621 (5%)	69 (7%)	11	5 (15%)	–
Physical education	724 (6%)	68 (7%)	9	–	–
Motor sports	249 (2%)	67 (7%)	27	1 (3%)	1 (25%)
Volleyball	1 239 (10%)	60 (6%)	5	–	–
Indoor soccer	631 (5%)	23 (3%)	4	–	–
Gymnastics ^d	126 (1%)	19 (2%)	15	–	–
Basketball	617 (5%)	19 (2%)	3	–	–
Martial arts	501 (4%)	15 (2%)	3	–	–
Hockey	626 (5%)	20 (2%)	3	–	–
Korfball	130 (1%)	15 (2%)	11	–	–
Tennis	246 (2%)	22 (2%)	9	–	–
Badminton	124 (1%)	19 (2%)	15	–	–
Handball	122 (1%)	13 (1%)	11	–	–
Swimming	127 (1%)	13 (1%)	10	2 (6%)	2 (50%)
Rest	1 472 (12%)	98 (10%)	–	–	–
Total	12 403 (100%)	980 (100%)	–	33 (100%)	4 (100%)

^aNumber and percentage of injuries, per type of sport, treated in the hospital.

^bSSI, Sports Severity Index: per type of sport; the quotient of the number of admissions and the number of injuries treated.

^cISS, Injury Severity Scale.

^dOutside school.

prisingly, there is a direct proportional relation between the ISS and the chance of being admitted because of an injury. This is in concordance with the results of a study by Kingma and Ten Duis.³⁰ With an ISS higher than or equal to 16, the chance of admission is nearly 100%. Although the ISS is often used to measure the severity of injuries,^{15,16} it is only seldom brought into practice with sports injuries. Ytterstad²⁵ and De Lões and Goldie¹⁸ only made use of the AIS, not the ISS. The results of Yamamoto *et al.*⁷ agree with our ISS results, but in a population limited to patients younger than 21 years old. As most patients admitted because of a sports injury have a low ISS (75% \leq 4), admission has to be based on other grounds, for example the need for a relatively small operation or observation of abdominal and head injuries. This hypothesis is in agreement with the results of the study by Van Der Sluis *et al.*³¹ stating that minor injuries (low ISS) might have serious consequences.

Mortality is used as the third criterion of severity. The number of deaths caused by sports participation is small, especially when related to the large number of sports injuries. From these results it has become clear that the usefulness of the ISS and mortality as a tool to measure the severity of sports injuries is questionable. Functional and social consequences of sports injuries, such as disabilities and handicaps, as tools of rehabilitation medicine, are not mapped out. Other variables measuring these consequences, such as the rate of admission (this study) or working and sporting time lost and sustained permanent damage (as reported by Van Mechelen,⁶ De Lões and Goldie¹⁸ and Caine *et al.*³²), may be more appropriate.

Severe sports injuries per type of sport

Injuries resulting in admission are mainly the result of practising soccer, horse riding, speed skating, physical education, motor sports or volleyball. Related to the number of injuries treated per type of sport (the Sports Severity Index) the sequence as mentioned above changes; for instance, soccer ends up eleventh instead of first while motor sports and horse riding become the most dangerous sports. In this way better data are provided about the relative risk of being

severely injured when playing in a particular category of sports.³⁰

Conclusion

Sports injuries rank second in the list of most frequent causes of injury, after home and leisure accidents and third in terms of severity, after traffic accidents and violence. Although with sports injuries the ISS and mortality is low, this does not rule out the possibility of serious consequences, such as a high admission rate (this study), disabilities and handicaps³¹ or high costs.⁴ In future research other measurements aimed at these consequences should be applied to optimize prevention and treatment strategies, including the input of rehabilitation medicine.

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